EMB190 Alerting Issues – Air data system failure

1. Initiating Condition: Blocked pitot source (captain's or left source)

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	"IAS" displayed in amber on the Capt and F/O PFD airspeed tapes (automatically swaps and displays "ADS 2"	Airspeed miscompare sensed between Capt and F/O PFDs	Resolution of the discrepancy requires effortful reference to standby airspeed display and/or to pitch/power displays; Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time.			Decrease of airspeed variance below threshold value
	PFD airspeed tape enters the amber, then red low speed bands.	Warning could be triggered by either (1) a false indication due to loss of dynamic pressure input to the pitot probe, or (2) a valid indication if pilot follows a different airspeed display that is reading an incorrectly low value into a true underspeed condition.	Resolution of the discrepancy requires effortful reference to standby airspeed display and/or to pitch/power displays; Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time.	High and low speed warnings may occur simultaneously (one valid, the other false) which could be especially confusing to the pilots		Low and high speed warnings may begin and end based on changes in altitude as well as airspeed

EMB190 Alerting Issues – Air data system failure

1. Initiating Condition: Blocked pitot source (captain's or left source) – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	PFD airspeed tape possibly enters the red/white striped high speed band	Indicated airspeed exceeds Vmo/Mmo, if a pilot follows a different airspeed display that is reading an incorrectly low value into a true overspeed (valid warning).	It may not immediately be evident to the pilots whether this is a true or false warning, especially in the presence of inconsistent airspeed displays			
	PFD digital airspeed display possibly turns red	Indicated airspeed exceeds Vmo/Mmo, if a pilot follows a different airspeed display that is reading an incorrectly low value	It may not immediately be evident to the pilots whether this is a true or false warning, especially in the presence of inconsistent airspeed displays			

EMB190 Alerting Issues – Air data system failure

1. Initiating Condition: Blocked pitot source (captain's or left source) – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
		into a true overspeed (valid warning).				
	Possible PFD annunciation OVSP	Indicated airspeed exceeds Vmo/Mmo, if a pilot follows a different airspeed display that is reading an incorrectly low value into a true overspeed (valid warning).	It may not immediately be evident to the pilots whether this is a true or false warning, especially in the presence of inconsistent airspeed displays			

EMB190 Alerting Issues – Air data system failure

1. Initiating Condition: Blocked pitot source (captain's or left source) – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Aural Alerts	Possible "High Speed" aural warning if a pilot follows a different airspeed display that is reading an incorrectly low value into a true overspeed (valid warning).	Indicated airspeed exceeds Vmo/Mmo	It may not immediately be evident to the pilots whether this is a true or false warning, especially in the presence of inconsistent airspeed displays			

EMB190 Alerting Issues – Air data system failure

1. Initiating Condition: Blocked pitot source (captain's or left source) – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Tactile Alerts	None					
Visual Cues	Displayed mach/airspeed is inconsistent with other pilot's and standby airspeed values		Depending on the nature of the blockage, the affected display may indicate low or zero airspeed (ram air input blocked), or may indicate a false airspeed increase as the aircraft climbs and decrease as the aircraft descends (both the ram air input and drain hole blocked)			
	Displayed mach/airspeed is inconsistent with displayed attitude, considering phase of flight, altitude, thrust, and weight		Resolution of the discrepancy requires effortful reference to and integration of pitch/power displays, considering multiple additional factors (weight, configuration, etc.) that must be recalled from memory or looked up			
	Displayed mach/airspeed is inconsistent with FMC ground speed/winds, IRS-displayed groundspeed, flight path vector displays		Resolution of the discrepancy requires effortful reference to multiple displays on the overhead panel and FMC, both of which may require switch selections or button pushes to display the relevant data, as well as consideration of multiple additional factors (winds aloft, true airspeed correction, etc.) that must be recalled from memory or looked up			

EMB190 Alerting Issues – Air data system failure

1. Initiating Condition: Blocked pitot source (captain's or left source) – Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Aural Cues	None					
Tactile/Somatic Cues	None					

Expected Pilot Response(s)

- Disconnect autopilot and autothrottle
- Adjust airplane attitude and thrust to maintain aircraft control
- Identify the incorrect airspeed display
- RVSM altitudes no longer allowed. Hence, lower altitudes must be used which may affect fuel burn and range. Consideration for fuel stop must be considered.
- Cat II operations may be affected and destination choices may have to be altered.

Possible sources of confusion with regard to pilot response(s)

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- Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time.

How does pilot know condition is resolved/recovered?

- IAS miscompare indications on PFDs are no longer displayed, and airspeed indications are consistent with attitude/thrust/aircraft performance parameters

EMB190 Alerting Issues – Air data system failure

2. Initiating Condition: Blocked pitot sources (all sources blocked, first partially and inconsistently, then completely), with ram air pressure trapped in at least one pitot system during climb (e.g., blocked pitot drain)

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	"IAS" displayed in amber on the Capt and F/O PFD airspeed tapes	Airspeed miscompare sensed between Capt and F/O PFDs	Resolution of the discrepancy requires effortful reference to standby airspeed display and/or to pitch/power displays; Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time.			Decrease of airspeed variance below threshold value
	PFD airspeed tape enters the amber, then red low speed bands	Warning could be triggered by either (1) a false indication due to loss of dynamic pressure input to the pitot probe, or (2) a valid indication if pilot follows a different airspeed display that is reading an incorrectly low value into a true underspeed condition.	Resolution of the discrepancy requires effortful reference to standby airspeed display and/or to pitch/power displays; Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time.	High and low speed warnings may occur simultaneously (one valid, the other false) which could be especially confusing to the pilots. During period of climb with ram air pressure trapped in the pitot system, low and high speed warnings may begin and end based on changes in altitude as well as airspeed		

EMB190 Alerting Issues – Air data system failure

2. Initiating Condition: Blocked pitot sources (all sources blocked, first partially and inconsistently, then completely), with ram air pressure trapped in at least one pitot system during climb (e.g., blocked pitot drain)– Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	PFD airspeed tape enters the red/white striped high speed band	Warning could be triggered by either (1) pressure trapped in a pitot system and ambient pressure decrease in the climb (false warning); or (2) a pilot following a different airspeed display that is reading an incorrectly low value into a true overspeed (valid	Resolution of the discrepancy requires effortful reference to standby airspeed display and/or to pitch/power displays; Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time.	High and low speed warnings may occur simultaneously (one valid, the other false) which could be especially confusing to the pilots. During period of climb with ram air pressure trapped in the pitot system, low and high speed warnings may begin and end based on changes in altitude as well as airspeed		

EMB190 Alerting Issues – Air data system failure

2. Initiating Condition: Blocked pitot sources (all sources blocked, first partially and inconsistently, then completely), with ram air pressure trapped in at least one pitot system during climb (e.g., blocked pitot drain)– Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
		warning).				
	PFD digital airspeed display turns red	Warning could be triggered by either (1) pressure trapped in a pitot system and ambient pressure decrease in the climb (false warning);	Resolution of the discrepancy requires effortful reference to standby airspeed display and/or to pitch/power displays; Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time.	High and low speed warnings may occur simultaneously (one valid, the other false) which could be especially confusing to the pilots. During period of climb with ram air pressure trapped in the pitot system, low and high speed warnings may begin and end based on changes in altitude as well as airspeed		

EMB190 Alerting Issues – Air data system failure

2. Initiating Condition: Blocked pitot sources (all sources blocked, first partially and inconsistently, then completely), with ram air pressure trapped in at least one pitot system during climb (e.g., blocked pitot drain)– Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
		or (2) a pilot following a different airspeed display that is reading an incorrectly low value into a true overspeed (valid warning).				
	PFD annunciation OVSP	Warning could be triggered by either (1) pressure trapped in a pitot system and ambient pressure decrease in the climb (false	Resolution of the discrepancy requires effortful reference to standby airspeed display and/or to pitch/power displays; Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time.	High and low speed warnings may occur simultaneously (one valid, the other false) which could be especially confusing to the pilots. During period of climb with ram air pressure trapped in the pitot system, low and high speed warnings may begin and end based on changes in altitude as well as airspeed		

EMB190 Alerting Issues – Air data system failure

2. Initiating Condition: Blocked pitot sources (all sources blocked, first partially and inconsistently, then completely), with ram air pressure trapped in at least one pitot system during climb (e.g., blocked pitot drain)– Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
		warning); or (2) a pilot following a different airspeed display that is reading an incorrectly low value into a true overspeed (valid warning).				
	Stick shaker aural warning	AOA	Stall warning may be valid if aircraft enters stall condition during loss of control while following incorrect airspeed references, but may not be considered to be valid by the pilots because of simultaneously displayed conflicting (high) airspeed and overspeed warnings (due to pitot system(s) in which the ram air pressure is trapped). Resolution of the discrepancy requires effortful reference to standby airspeed display and/or to pitch/power displays; Pilots may follow incorrect airspeed guidance into an undesired aircraft	False warning may prompt pilots to react with control inputs that actually result in or exacerbate loss of control. During period of climb with ram air pressure trapped in the pitot system, low and high speed warnings may begin and end based on changes in altitude as well as airspeed		

EMB190 Alerting Issues – Air data system failure

2. Initiating Condition: Blocked pitot sources (all sources blocked, first partially and inconsistently, then completely), with ram air pressure trapped in at least one pitot system during climb (e.g., blocked pitot drain)– Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
			state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time			

EMB190 Alerting Issues – Air data system failure

2. Initiating Condition: Blocked pitot sources (all sources blocked, first partially and inconsistently, then completely), with ram air pressure trapped in at least one pitot system during climb (e.g., blocked pitot drain)– Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Aural Alerts	"High Speed" aural warning	Indicated airspeed exceeds Vmo/Mmo. Warning may be triggered by either (1) pressure trapped in a pitot system and ambient pressure decreases (false warning); or (2) a pilot following a different airspeed display that is reading an incorrectly low value into a true overspeed (valid warning).	Resolution of the discrepancy requires effortful reference to standby airspeed display and/or to pitch/power displays; Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time.	Pilots responding to a false overspeed warning may enter or exacerbate a loss of control. During period of climb with pitot drain blocked, low and high speed warnings may begin and end based on changes in altitude as well as airspeed		

EMB190 Alerting Issues – Air data system failure

2. Initiating Condition: Blocked pitot sources (all sources blocked, first partially and inconsistently, then completely), with ram air pressure trapped in at least one pitot system during climb (e.g., blocked pitot drain)– Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Tactile Alerts	Stickshaker warning	AOA	Stall warning may be valid if aircraft enters stall condition during loss of control while following incorrect airspeed references, but may not be considered to be valid by the pilots because of simultaneously displayed conflicting (high) airspeed and overspeed warnings (due to pitot system(s) in which the ram air pressure is trapped). Resolution of the discrepancy requires effortful reference to standby airspeed display and/or to pitch/power displays; Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed display may appear valid and the process of identifying the discrepant display(s) may require substantial time	False warning may prompt pilots to react with control inputs that actually result in or exacerbate loss of control. During period of climb with pitot drain blocked, low and high speed warnings may begin and end based on changes in altitude as well as airspeed		
Visual Cues	Until complete blockage of all pitot probes, displayed mach/airspeed is inconsistent with other pilot's and standby airspeed values		Depending on the nature of the blockage, the affected displays may indicate low or zero airspeed (ram air input blocked), or may indicate a false airspeed increase as the aircraft climbs and decrease as the aircraft descends (during period both the ram air input and drain hole blocked)			

EMB190 Alerting Issues – Air data system failure

2. Initiating Condition: Blocked pitot sources (all sources blocked, first partially and inconsistently, then completely), with ram air pressure trapped in at least one pitot system during climb (e.g., blocked pitot drain)– Cont.

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Visual Cues	Displayed mach/airspeed is inconsistent with displayed attitude, considering phase of flight, altitude, thrust, and weight		Resolution of the discrepancy requires effortful reference to and integration of pitch/power displays, considering multiple additional factors (weight, configuration, etc.) that must be recalled from memory or looked up			
	Displayed mach/airspeed is inconsistent with FMC ground speed/winds, IRS-displayed groundspeed, flight path vector displays		Resolution of the discrepancy requires effortful reference to multiple displays on the overhead panel and FMC, both of which may require switch selections or button pushes to display the relevant data, as well as consideration of multiple additional factors (winds aloft, true airspeed correction, etc.) that must be recalled from memory or looked up			
Aural Cues	None					
Tactile/ Somatic Cues	Aerodynamic buffet	Actual overspeed or approach to stall	Not definitive as to cause, may suggest either high or low speed excursion			

Expected Pilot Response(s)

- Disconnect autopilot and autothrottle
- Adjust airplane attitude and thrust to maintain aircraft control
- Perform UNRELIABLE AIRSPEED procedure to identify the incorrect airspeed displays and reference body angle/thrust values for desired performance
- RVSM altitudes no longer allowed. Hence, lower altitudes must be used which may affect fuel burn and range. Consideration for fuel stop must be considered.
- Cat II operations may be affected and destination choices may have to be altered.

EMB190 Alerting Issues – Air data system failure

2. Initiating Condition: Blocked pitot sources (all sources blocked, first partially and inconsistently, then completely), with at least one blocked pitot drain, during climb – Cont.

Possible sources of confusion with regard to pilot response(s)

- With blocked pitot input sources and ram air trapped in the pitot system, the pilot conceivably may receive high speed aural warning and low speed (stick shaker) warnings simultaneously, which is extremely confusing, stressful, and distracting
- If the aircraft is flown into an actual overspeed condition with all air data inputs missing or invalidly low, the expected overspeed warnings will be absent. The absence of an expected warning can be confusing and inhibit pilots' identification of the overspeed condition.
- Pilots may follow incorrect airspeed guidance into an undesired aircraft state or loss of control, because the airspeed displays may appear valid and the process of identifying the discrepant display(s) may require substantial time.
- UNRELIABLE AIRSPEED procedure is unannunciated.

EMB190 Alerting Issues – Air data system failure

3. Initiating Condition: Air data computer failure (single module or unit)

Type	Alert or cue	Threshold for alert or cue to be presented	Confusion regarding alert or cue	Other issues with regard to alert or cue	When alert is inhibited/ suppressed or when cue is masked	How alert or cue is terminated
Visual Alerts	On the Captain's PFD (normally fed by the failed ADS), amber "ADS3" indication in upper left corner	Sensed loss of source input from on-side ADS (ADS1) and automatic switch to first reversionary mode (ADS3)	None			
	Master caution blinking amber lights on L&R glareshield	Triggered by EICAS Caution Messages ADS 1 FAIL	None		EICAS inhibited 80kt to 400ft and 200 ft to landing roll	Blinking terminates when the Master Caution light/pushbutton is pressed
	EICAS caution message ADS 1 FAIL (amber, flashing/reverse video)		None		EICAS inhibited 80kt to 400ft and 200 ft to landing roll	Flashing/reverse video of the text ceases terminates when the Master Caution light/pushbutton is pressed
	ADS sensor reversion button on the reversionary panel (forward instrument panel) is illuminated in white.	Sensed loss of source input from on-side ADS (ADS1) and automatic switch to first reversionary mode (ADS3)	None			
Aural Alerts	Single chime	Triggered by EICAS Caution Messages ADS 1 FAIL	None			
Tactile Alerts	None					
Visual Cues	None					
Aural Cues	None					
Tactile/ Somatic Cues	None					

EMB190 Alerting Issues – Air data system failure

3. Initiating Condition: Air data computer failure (single module or unit) – Cont.

Expected Pilot Response(s)

- Perform ADS1 FAIL QRH procedure
- As prompted by the QRH procedure, consider whether continued flight in RVSM airspace is permitted.
- Cat II operations may be affected and destination choices may have to be altered.